THE LONGITUDINAL DISTRIBUTION OF THE FRESHWATER MUSSELS (UNIONIDAE) OF KINNICONICK CREEK, NORTHEASTERN KENTUCKY

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ABSTRACT

Kinniconick Creek, a sixth-order high quality stream in northeastern Kentucky, yielded 19 native and one introduced species of freshwater bivalves during a recent survey. Longitudinal distribution analysis indicated general agreement with patterns observed for fish and other invertebrates with an increase in the average number of species from 0.5 in the headwaters to 17 in the middle reaches; however, an abrupt decrease to 2.5 was noted at the lowermost stations. Species commonly encountered in descending order of frequency were: *Lampsilis radiata luteola, Ptychobranchus fasciolaris, Fusconaia flava, Corbicula fluminea, Elliptio dilatata, Epioblasma triquetra,* and *Lampsilis ventricosa.* Species judged as rare or of limited distribution were: *Elliptio crassidens crassidens, Anodonta grandis grandis, Lampsilis fasciola, Leptodea fragilis, Quadrula pustulosa pustulosa,* and *Simpsonaias ambigua.* Calculation of faunal resemblance indices for Kinniconick Creek and seven other similar-sized Ohio River valley streams indicated the strongest resemblance with direct middle and upper Ohio River tributaries and the weakest resemblance to a Cumberland River tributary of the lower Ohio valley. The diverse pelecypod fauna of Kinniconick Creek is regarded as exemplary of undisturbed small to medium-sized watersheds in the middle Ohio River; however, the integrity of the fauna is threatened by potential extraction of oil-shale deposits from the watershed.

During an inventory of Kentucky's highest quality aquatic systems (Hannan et al., 1982), Kinniconick Creek in northeastern Kentucky was examined for the presence of freshwater bivalves (Fig. 1). Interest in the mussel fauna of small to medium-sized streams within the middle and upper Ohio River valley has increased in recent years as exemplified by surveys in Indiana, Kentucky, and West Virginia (Houp, 1980; Taylor, 1980a, b, 1981, 1982; Taylor and Spurlock, 1981). This interest stems from growing concern over documenting distributions of rare naiad species within various Ohio River valley states (Stansbery, 1971; Branson et al., 1981), identification of naiad refugia for reinvasion of perturbated rivers and streams (Taylor, 1980a, 1981; Hannan et al., 1982), and the recognition by aquatic biologists and water regulatory agencies of the value of bivalves in documenting changes in ambient water quality associated with stream pollution (Stansbery, 1969; Starrett, 1971; Blankenship and Crockett, 1972; Taylor, 1980c). Relatively undisturbed streams such as Kinniconick Creek are of particular interest and value since they can serve as baseline lotic systems with which others are compared.

The primary purpose of this study was to document the naiad fauna of Kinniconick Creek, describe observed distributional patterns, and compare the fauna of Kinniconick Creek with that of other similar-sized Ohio River valley streams.

METHODS

Study design followed recommendations set forth by Stansbery (1981, pers. comm., i.e., collect 1–3 hr/station with stations 1.6–4.8 km apart situated from headwaters to mouth) to insure as complete coverage of the fauna as possible. Fifteen stations on the mainstem of Kinniconick Creek were surveyed for mussels on 14 July and 14–15 September, 1982 (Fig. 1, Table 1). Tributary streams were primarily dry and thus were not surveyed. Live mussels,

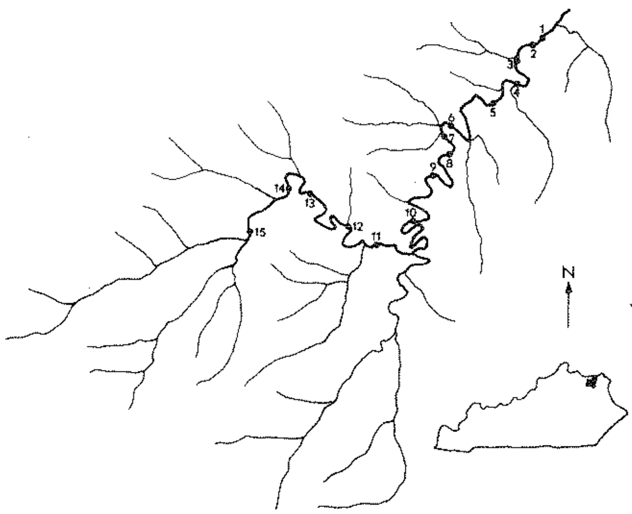

Fig. 1 Sampling stations on the mainstem of Kinniconick Creek, northeastern Kentucky.

along with fresh dead and/or relic shells, were handpicked from shallow water at each station. Shells were also collected from the shoreline, until further searching revealed no additional new species. An average of 2.6 man-hours (0.45–6.00) was spent searching at each station. All specimens were deposited at the Ohio State University Museum of Zoology. Geology, station locations, stream order, and gradients were determined from current United States Geological Survey 7.5 minute topographic and geologic quadrangle maps. Nomenclature follows Stansbery (1982). To estimate resemblance of faunas between two streams, Long's (1963) average resemblance formula was used as follows:

$$C(N_1 + N_2)(100)/2N_1N_2 = \text{average resemblance index (percentages)}$$

C = number of forms common to both faunas
N_1 = number of forms common to smaller fauna
N_2 = number of forms common to larger fauna

Average resemblance index values range from 0 to 100, where 0 indicates that the two faunas have no forms in common, and 100 indicates that the two faunas are identical.

STUDY AREA

Kinniconick Creek is a sixth-order stream arising in Lewis County, Kentucky, at approximately 335 m above mean sea level and flowing 82 km before debouching into the Ohio River at river kilometer 592 at an altitude of 148 m. Average stream gradient from headwaters to mouth is 2.3 m/km. At the time of sampling, the mainstem from stations 1–10 was characterized by long, deep (1.6 m), clear pools

Table 1. Longitudinal distribution of species by station in Kinniconick Creek, Kentucky (L = live specimen, FD = fresh dead specimen, WD = weathered dry specimen, F = fragment).

	1	2	3	4
Leptodea fragilis (Rafinesque, 1820)	WD			
Corbicula fluminea (Müller, 1774)	L	L	L	L
Simpsonaias ambigua (Say, 1825)	FD			
Epioblasma triquetra (Rafinesque, 1820)		WD		
Lampsilis fasciola Rafinesque, 1820			L	
Elliptio dilatata (Rafinesque, 1820)			L	
Ptychobranchus fasciolaris (Rafinesque, 1820)			L	
Lampsilis ventricosa (Barnes, 1823)			L	
Lampsilis radiata luteola (Lamarck, 1819)			L	
Villosa lienosa (Conrad, 1834)			L	
Fusconaia flava (Rafinesque, 1820)			WD	
Elliptio crassidens crassidens (Lamarck, 1819)				
Lasmigona costata (Rafinesque, 1820)				
Quadrula pustulosa pustulosa (Lea, 1831)				
Potamilus alatus (Say, 1817)				
Amblema plicata plicata (Say, 1817)				
Villosa iris iris (Lea, 1829)				
Strophitus undulatus undulatus (Say, 1817)				
Tritogonia verrucosa (Rafinesque, 1820)				
Anodonta grandis grandis (Say, 1829)				
Location (km from mouth)	3.1	3.2	5.8	8.6
Gradient (m/km)	0.86	0.86	1.31	1.31
Total Species/Station	3	2	8	1

Total Species = 20

alternating with short, shallow (7.5–30 cm) riffles of slow to moderate current underlain by gravel and cobble with scattered boulders. Near station 11 a sharp increase in gradient was noted (Fig. 2) and the large pools in this area were separated by long, steep riffles predominated by large cobble, boulder, and bedrock. Field observations indicated that tributaries and the headwaters (above station 15) of Kinniconick Creek were dry or reduced to shallow isolated pools at the time of the survey.

The Kinniconick drainage lies immediately to the west of Pennsylvanian age caprocks defining the edge of the non-glaciated Allegheny Plateau. Quarterman and Powell (1978) described the region as the Northeastern Blue Grass Subsection of the Blue Grass Section of the Interior Low Plateaus Province. The majority of this subsection is within the Kinniconick Creek drainage. Vegetation in the watershed is 90–95% second-growth forest with agricultural development (pasture and row-crops) limited to the generally narrow floodplain. The potential natural vegetation is classified as mixed mesophytic forest (Kuchler, 1964) and is similar to adjacent areas in the non-glaciated Allegheny Plateau. Ridgetops in the watershed are capped by Mississippian age siltstone and shale. Valley slopes are predominantly Mississippian age sandstone, which forms large slump blocks, prominent ledges, and bluffs in parts of the drainage, and to a lesser extent, thin alternating layers of shale and siltstone. Along Kinniconick Creek proper, outcrops of Devonian age Ohio shale or "oil shale" are exposed. The floodplain is composed of Quaternary age alluvium, much of which is derived from tributaries. Substrate particle sizes range from boulder to silty sand, but pebble and cobble, composed of carbonate rocks, siltstone, sandstone, silty shale, and chert predominate. In several areas the creek has cut through the alluvium to expose bedrock. Tributary streams such as McDowell Creek and Laurel Fork are used as sources of gravel for surfacing secondary roads as evidenced by bulldozing in these stream beds during fieldwork.

RESULTS

Collection efforts in Kinniconick Creek yielded 19 native and one introduced species (*Corbicula fluminea*) of freshwater bivalves (Table 1). Shells were generally in good to excellent condition showing little sign of umbo or periostracum erosion. The bulk of the collections was comprised of live specimens; relic or fresh dead shells were scarce both in and along the stream.

For comparative purposes the average number of species was determined for nine segments (stations 1–2, 3–4, 5, 6–8, 9–10, 11, 12, 13, and 14–15, respectively) of the stream having different calculated gradients (Fig. 2). The number of species present in segments represented by a single station was considered an average for that segment.

(Table 1, continued.)

5	6	7	8	9	10	11	12	13	14	15
L										
L	WD									
		L								
L		L	L	WD	L					
L										
L		L	L	WD	L					
L	F	L	L	L	WD					
L		L	L	L		L				
L		L	L	L	L	L	L			
L			FD				L			
L		L	L	WD	L					F
L										
L			L							
L			FD							
L			FD	L						
L		WD	L		FD					
L		WD			FD					
L		L	L		L		L			
		L	L	L	L					
						L	L			
11.9	19.1	20.4	22.5	25.1	29.8	41.3	45.6	50.3	55.0	60.0
0.69	1.35	1.35	1.35	0.80	0.80	1.43	1.42	3.14	0.91	0.91
17	2	11	13	8	9	3	4	0	0	1

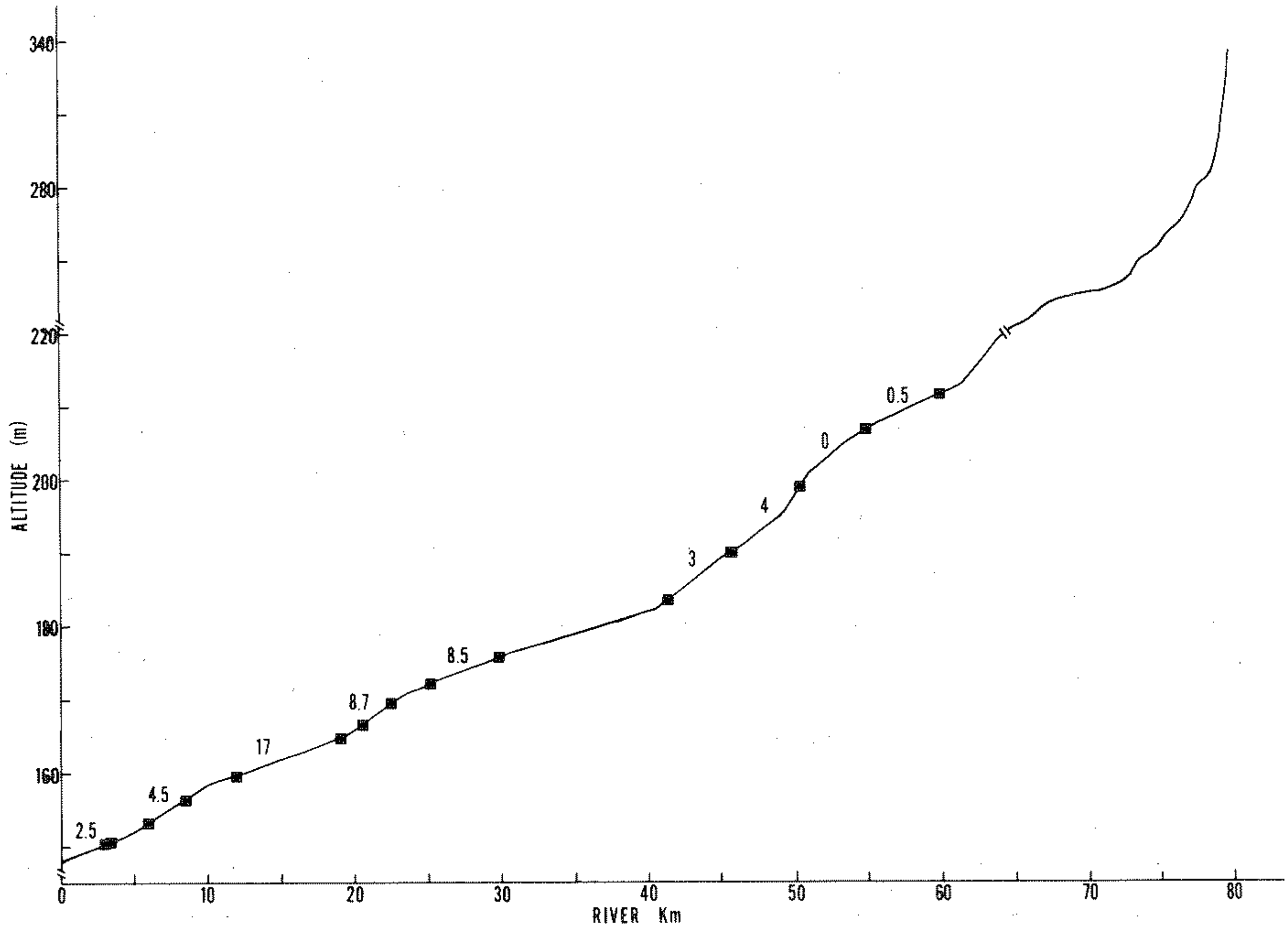

Fig. 2 Average number of species from segments of different calculated gradients in relation to altitudinal changes in Kinniconick Creek mainstem. (Collecting stations are denoted by solid squares).

The average number of species per segment increased from 0.5 (stations 14–15) in the headwaters to 17 in the middle reaches (station 5) and decreased abruptly near the mouth to 2.5 (stations 1–2). Rank correlation ($r = -0.52$) between gradient and average number of species per segment was not significant ($P < 0.5$).

The most commonly encountered species (40% or more stations) in descending order of importance were: *Lampsilis radiata luteola* (53%), *Fusconaia flava* (47%), *Ptychobranchus fasciolaris* (47%), *Corbicula fluminea* (40%), *Elliptio dilatata* (40%), *Epioblasma triquetra* (40%), and *Lampsilis ventricosa* (40%). Species judged as rare or of limited distribution (less than 15% of the stations) within the drainage were: *Anodonta grandis grandis* (13%), *Lampsilis fasciola* (13%), *Leptodea fragilis* (13%), *Quadrula pustulosa pustulosa* (13%), *Simpsonaias ambigua* (13%), and *Elliptio crassidens crassidens* (7%). Calculation of faunal resemblance indices for Kinniconick Creek and other similar-sized streams in the Ohio River basin (Table 2) revealed a range of 46–76% with the strongest resemblance to direct Ohio River tributaries and the least resemblance to a Cumberland River tributary. Comparison of the fauna of Kinniconick Creek with seven other small to medium-sized Ohio River valley steams (Houp, 1980; Taylor, 1980a, b, 1981, 1982; Zeto, 1980; Starnes and Bogan, 1982) revealed that *Alasmidonta viridus, Obovaria subrotunda*, and *Lasmigona complanata* were present in 71%, 57%, and 57%, respectively, of the other streams but were not collected in Kinniconick Creek. Conversely, species present in Kinniconick Creek but not reported from a large percentage of other streams were: *E. c. crassidens* (86%), *Villosa lienosa* (86%), *S. ambigua* (71%), *E. triquetra* (71%), and *Q. p. pustulosa* (57%).

DISCUSSION

The occurrence of 20 species of bivalves in Kinniconick Creek (Table 1) compares favorably with other small to medium-sized streams previously surveyed in the Ohio River drainage (Table 2). The representation of all species in Kinniconick Creek by live specimens, most of which occurred at several stations, indicates a healthy, viable fauna and attests to the overall quality of the drainage.

Examination of the distribution pattern (Table 1) indicates longitudinal succession similar to that observed elsewhere for fish and invertebrate species (Kuehne, 1962; Harrell and Dorris, 1968; Starnes and Bogan, 1982). With few exceptions the distribution pattern consisted primarily of addition and/or replacement of species in a downstream direction. The most speciose and dense populations were observed in the generally moderate-gradient middle reaches of the stream (stations 5–10) (Fig. 2) with an increasingly depauperate fauna occupying the higher gradient upstream stations (11–15) and the region near the mouth (stations 1–4).

The diminution of diversity in the headwaters is consistent with observations of Starnes and Bogan (1982). Although there was no significant correlation between gradient and average numbers of species per segment, the data indicated a trend in the middle and upper segments toward decreased diversity at higher gradients as illustrated in Figure 2. A rapid decrease in number of species was particularly evident between stations 10 and 11. Other factors associated with gradient such as decrease in flow, stream size, and ultimately habitat heterogeneity are also probable factors in decreased diversity in upstream reaches.

The abrupt decline in number of species near the mouth of Kinniconick Creek (stations 1–4) was unexpected and represented an exception to the classical depiction of increased diversity along longitudinal gradients. Several plausible factors could be responsible for this observed distributional pattern. The influence of the impounded Ohio River on the lower reaches may at times of high water reduce flow, increase sedimentation, and inundate riffle-pool habitat. The lower gradient of Kinniconick Creek subsequent to its plunge onto the large Ohio River floodplain (Fig. 2) and the associated increase in alluvium may also have acted to reduce habitat heterogeneity and thus the number of species. Another possible factor is the increased anthropogenic influence on the floodplain. Although the collecting methods may have contributed to the lower number of species observed near the mouth, based on the preponderance of pool habitat and the factors previously discussed, it is believed that collecting methods alone could not account for the dramatic difference in diversity between the middle and lower reaches. In general, lowered diversity at any given station could be associated with a preponderance of pool habitat, unstable or shifting gravel substrates, extensive bedrock or large boulder substrate, and/or increased gradient.

Table 2. Total species and faunal resemblance indices for Kinniconick Creek and other small to medium-sized Ohio River basin streams.

Stream (Location)	No. Species	Faunal Resemblance (%)
Big Indian Creek (Ind.)[1]	17	76
Tygarts Creek (Ky.)[2,3]	22	76
Middle Island Creek (W. Va.)[4]	23	75
Floyds Fork Salt River (Ky.)[5]	20	70
Eagle Creek (Ky.)[6]	21	68
Red River (Ky.)[7]	15	58
Little South Fork Cumberland River (Ky.)[8]	24	46
Kinniconick Creek (Ky.)	20	—

[1]Taylor (1982); [2]Taylor (1980a); [3]Zeto (1980); [4]Taylor and Spurlock (1981); [5]Taylor (1980b); [6]Taylor (1981); [7]Houp (1980); [8]Starnes and Bogan (1982)

The fauna occupying Kinniconick Creek is, as expected, typically Ohioan. Faunal resemblance values (Table 2) indicate strong similarity among species assemblages in Kinniconick Creek and those occupying nearby direct Ohio River tributaries in Indiana, Kentucky, and West Virginia. Similarity of faunas decreases in those streams of the middle Ohio River valley which are not direct Ohio River tributaries. This suggests that the proximity of the Ohio River mainstem is an important factor in determining faunal make-up of small tributaries such as Kinniconick Creek. Of particular note is the low faunal resemblance between Kinniconick Creek and Little South Fork Cumberland River which illustrates that the disparity between the Ohioan and Cumberlandian pelecypod faunas (Ortmann, 1926) is apparent even in relatively small tributaries.

Habitat information provided in Ortmann (1919) and Parmalee (1967) for the bivalve species observed in Kinniconick Creek indicates that most are dependent on riffle habitat or current. Only a small number of the species present was associated with lentic environments. Two of the typically lentic forms, *Anodonta grandis grandis* and *Leptodea fragilis*, were restricted to the upstream and downstream reaches of the stream, respectively. The preponderance of riffle or rheophilic species with an admixture of lentic forms is to be expected in a stream like Kinniconick Creek which has good riffle-pool development and a variety of bottom types.

With the exception of *Corbicula fluminea* and *Lampsilis ventricosa*, all the other species denoted as common are typically associated with stream or small river habitats (Ortmann, 1919; Parmalee, 1967). *Lampsilis ventricosa* is also associated with big river habitats. *Corbicula fluminea* is a ubiquitous species which, since its introduction, is a common inhabitant of small streams to large rivers throughout

Kentucky (pers. obs.). The species was totally absent above station 6 in this study, although it was extremely abundant in the lower reaches of the stream. The factor(s) responsible for its inability to colonize the remainder of Kinniconick Creek are unknown; however, stream size and suitable substrate do not appear to be limiting. Of the species with limited distribution within the stream the presence of *Elliptio crassidens crassidens* is surprising because of its well-known preference for large rivers and strong currents (Ortmann, 1919; Parmalee, 1967). Its rarity in Kinniconick Creek and absence from most of the other streams previously cited (Table 2) further documents this preference. The presence of *E. c. crassidens* in Kinniconick Creek is most likely associated with the proximity of the Ohio River, and it probably has never been a prominent component of the Kinniconick Creek fauna.

Of particular interest was the occurrence of *Epioblasma triquetra, Villosa lienosa*, and *Simpsonaias ambigua* in Kinniconick Creek and their conspicuous absence from a majority of other previously cited streams of the Ohio River valley. In Kentucky, these species are recognized as of special concern, endangered, and of undetermined status, respectively, by the Kentucky Academy of Science (Branson et al., 1981). Their absence from other Ohio River valley streams could be attributable to an artifact of collecting. For example, Parmalee (1967) notes that *E. triquetra* is easily overlooked by collectors due to its habit of deeply burying itself. However, both *V. lienosa* and *S. ambigua* have been decimated in parts of their range (Parmalee, 1967) and populations in Kinniconick Creek offer continued hope for their persistence both in Kentucky and the middle Ohio River valley.

Kinniconick Creek represents a high-quality, relatively undisturbed middle Ohio River valley stream which to date has escaped all but low-impact watershed development. Aside from its diverse pelecypod fauna, the stream also supports a self-sustaining muskellunge (*Esox masquinongy*) population as well as a diverse ichthyofauna (Kornman, 1982, pers. comm.; Warren and Cicerello, 1983). Based on its biological merits, the stream was recently recommended for inclusion as an Outstanding Resource Water in Kentucky (Hannan et al., 1982). Unfortunately, the future maintenance of these qualities is uncertain due to recent investigations into the feasibility of extracting oil shale deposits located in the watershed. The resultant surface mines, inevitable increase in siltation, and potential for acid run-off threaten not only the indigenous unionid fauna, but also the integrity of the entire watershed. Continuing efforts by state agencies, interested academicians, and researchers will hopefully help to preserve Kinniconick Creek and its fauna.

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